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BOSTON UNIVERSITY

GRADUATE SCHOOL

Thesis

UNITS OF APPRECIATION IN GENERAL SCIENCE

Submitted by

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(B.S.,in Ed., Boston Teachers College, 1927)

In partial fulfilment of requirements for

the degree of Master of Arts

1929

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General Outline

Statement of the Problem Page 2

Introduction Page 3

The Objectives in General Science Page 4

Specific Aims and Principles Page 6

The Appreciation View Point Page 8

The Selection of Units Page 12

Criteria for selection of Units Page 15

Octopus leadings in Science Page 18

The Units of Appreciation Developed

I. (a) Breathing and Ventilation Page 22

(b) Carbon Dioxide Page 27

II. (a) Water Page 32

(b) Ice Page 36

(c) Steam Page 39

III. (a) Fuel and Fire Page 43

(b) Fire Prevention Page 46

IV. (a) Food and its Protection Page 51

V. (a) Magnets Page 56

(b) Frictional Electricity Page 58

Motivation of Units Page 61

Conclusion, including a general check up on the work, personal habits developed and creative outcomes. Page 66

Summary Page 71

Bibliography Page 72

PROBLEM

Units of Appreciation in General Science for grades 6 and 7. Units that may be easily understood and simply demonstrated.

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General Science

INTRODUCTION

General Science is the science of common things. The subject matter should be selected from the immediate environment and presented so that the child will be enabled to interpret the ordinary things about him intelligently.

The Sciences were born in very humble surroundings. (1)

Botany was first studies by the women of the tribe who sought for simple herbs to cure common diseases.

Zoölogy began with the observations of the habits of wild and domesticated animals.

Astronomy was first studied by the dwellers in open spaces who guided their steps by the sun, the moon and the stars. When to these pursuits were added the ingredients of curiosity and wonder it came to pass that after many centuries men of leisure devoted all their time to the investigation of one or another of these fields.

The first value of these fields of knowledge as subjects of schooling lies in the fact that they add to human morale by calling to the attention of youth the brilliance of the intellectual achievements of genius. The second value is the influence upon the practices of civilization. The discoveries in electricity which have made possible such conveniences as electric lighting and electric power, gasoline engines and rapid transportation. The X-ray and its applications to medicine. (2)

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(1) W.W.Charters Curriculum Construction p.14
(2) W.W.Charters Curriculum Construction p.15

The Great Objectives in General Science

In teaching General Science it is necessary to keep in mind its objectives.

To impart health instruction as one of its chief ends

To develop the pupils purposeful interest in the life of the environment by giving a first hand acquaintance with plant and animal neighbors.

To familiarize the pupil with the structure and functions of his own body in order that he may know why he must live healthfully so that he may live happily and usefully.

To train the pupil to observe life phenomena accurately and to form logical conclusions through projects essential to the productive work of life.

To enrich the life of the pupil through the aesthetic appeal of plants and animals studied to the end that he may enjoy nature. (1)

To demonstrate to the pupil the value of intensive study of science as a means through which progress is attained.

To create the ability, disposition, and habit of diversified observation of men, things and affairs as an enjoyable and fruitful leisure occupation. To form the habit of abundant diversified reading as a means of enjoyable

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(1) H.C.Hines Junior High School Curricula p.121, 122.

fruitful indirect observation of men, things and affairs; and of entering into the thoughts and affairs of others.

A disposition towards experimentation, exploration and invention in those fields of one's activity and interests which permit initiative.

A proportioned intellectual apprehension of the realities which make up the world of man's life.

The ability to see one's environment and to realize one's interrelatedness with and within this boundless environment. (1)

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(1) F.Bobbitt How to Make a Curriculum p.141, 143.

Specific Aims and Principles

For the right appreciations of the marvellous world in which one dwells, one needs breadth of vision and depth of insight that can come only from viewing understandingly the things and forces of which it is made.

Science should give a balanced vision and understanding of the realities near and remote which surround man.

The science training should aim at developing life long interests, attitudes, appreciations and mental alertness.

Science understanding should be a matter of gradually expanding growth.

Every aspect of Science should be introduced by full, direct and normal contacts with the concrete realities themselves.

The Science work of the school should be kept in close touch with the affairs of everyday life, and especially with matters that lie nearest to the interest of growing individuals. (1)

One's out of School experiences should be utilized for science training as fully as possible.

Biographies of pioneers in scientific exploration and discovery make valuable backgrounds for presenting the science which they discovered.

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(1) F.Bobbitt. How to Make a Curriculum. p.136, 137.

The habit of Science reading should be formed in ways and under conditions in which it should continue to function throughout life. (1)

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(1) F.Bobbitt. How to Make a Curriculum. p.138.

The Appreciation View Point

The purpose of General Science is to familiarize the pupil with his everyday surroundings, making them significant to him and furnishing him with a common background for the specialized sciences in the senior high school.

My plan is to show how a few units taken from the field of general science may be treated on an appreciation basis --- for the pure enjoyment of the subject and incidentally finding out some of the "whys" of things.

I think that science above all subjects was meant to be enjoyed. Interest is its life and backbone. It is so full of thrills and mystery, so much happiness and wonder lurks in every corner that the pity is that oft times the method of presentation kills it. Let us not stifle the enthusiasm. The subject can be made so alive, the story is never ended and the most interesting chapter is always to come.

Science plays such a large part in our every day life that there is no escaping it. No matter where we turn we are confronted with the products of scientific investigation. If things of a scientific nature are presented to the child, simply, and if he is permitted to follow his natural bent and study those things that interest him, life to him becomes fuller and richer. Children are naturally curious, it is one of the healthy signs of an intelligent child. Here is where the school can play directly into the child's hands by directing that curiosity and leading it into helpful channels.

There is so much in the field of science that is interesting, helpful, entertaining and educational, so much to draw from, that it

should be an easy task to make the subject attractive and functional.

I have started with General Science in the sixth grade, first, because many children never get beyond grade VI before they are called upon to go to work and hence have but little opportunity of being introduced into the science work. Again often children choose a course in the seventh grade which substitutes another subject for science and thus lose much that is vital and interesting. There is not much time alloted to science in Grade Vi, but there is a provision, and since it is considered, it should be made real. Science deals with life and its problems, then let it be as interesting as life itself. By making the little attractive an agreeable taste is fostered and an appetite created. General Science may be splendidly tied up with the health education and nature study, actually supplementing and reinforcing them.

If the work is made attractive children will respond. Make the work a pleasure and invite those who are interested. Children as a rule like to be invited; the feeling of task and the irkesomeness of drudgery are dispelled when the lesson is a sociable gathering.

Children can be guided in their choice of units often picking the very things you want them to learn. If the work is placed within the compass of the child - if he can perform - then interest is awakened. If he is but a spectator the interest flags and becomes but passive. Children naturally like to do. Then why not let them!

Science should be kept in close touch with the child's life - only as it affects him will he respond with interest.

If there is a freedom of choice in studying, the interest runs high. There is such a wide field to draw from, such a diversity of interests, that all are bound to be satisfied.

One needs but infinite patience, a willingness to help and a cheerful guiding spirit and part of the race is won. It is the old story; give the child a sizeable task, opportunity to do, a healthy atmosphere in which to work and happiness and success walk hand in hand.

Let the children realize that Science functions first as a guidance of practical activities of many kinds. (1)

Living as we do in the midst of a bewildering maze of mechanical appliances we need to know the wise use of them.

In the current community life, one is called upon to deal with innumerable chemical creations; each having its own special work to do because of its special characteristics: we need to know their values, how to avoid waste and dangers, their properties, their effects and conditions of their actions.

In the matter of health men and women are concerned with the chemistry, physics, bacteriology, and biology of the body. In the main health guidance is to be self guidance.

As citizens men and women are concerned with the city water supply, milk supply, ice supply, telephone system and ventilation of public buildings, and numerous other matters involved in the civic promotion of the general welfare.

Secondly that Science functions as a mode of living. (2)

It is a type of intellectual human activity. It is the common human experience of looking at surrounding realities.

It is seeing one's environment. It is the sort of thing any alert man is doing. To see widely one needs to draw upon the vision of others. To see hidden and remote things one needs to use the vision of those who

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(1) F.Bobbitt. How to Make a Curriculum. p.129.
(2) F.Bobbitt. How to Make a Curriculum. p.132.

have seen.

Science is real activity. It is spontaneously looking at the world of reality as a satisfying or enjoyable type of experience.

Selection of Units

In selecting units for study one must consider the environment, as topics are apt to be influenced by it.

However, there are certain outstanding units that are common to all and may be studied in any community - units that touch and enter into the lives of all and are large enough to permit of special treatment.

The units should be functional - not only to interest for the present but that the seeds of investigation may be subtley planted for future germination in the fields of experiment and exploration.

Discuss the field of science with the children, open up its doors of promise - let them choose the things they would like to know more about. Group their suggestions under certain large headings deciding whether they relate to fire, water, ventilation etc. Survey the field that most interests the children and select units that may be worked out from the child's point of view.

In the selection of units to be developed, it is often possible to work from a lead, given by an individual or the group.

In selecting my units I have been guided by leads given by the children; by watching them at play, at leisure and out of school interests, noting the things they were doing or wanted to do. The units for the most part may be used through the use of experiments to stress points suggested in the health program and nature study making these subjects more practical and vital to the child and bringing home the truths concretely.

As the leads were taken or the suggestions given, they were grouped under the various headings as Fire, Air, Water, Magnetism or Electricity.

Of course where the field is entirely new and the children have no

background whatever, then the teacher must supply that background, but even then I think there are often leads presented if one is on the watch for them, certainly environment is a help in the situation.

The units themselves should be kept very simple especially in grade VI where the introduction of general science should serve only to create a love and taste for the work. Naturally of course the higher the grade the more extensively will the unit be pursued. I have therefore selected those units which are large enough to allow for special treatment and independent work forming a basis for the appreciation of work in the field later.

In the five units which I have chosen three were suggested by leads supplied by the children themselves, questions asked that brought about the demonstrations.

Two of the units were developed through both leads and environment; and one because the stage was set for it.

In the work in Health education the pupils were given a lecture on the proper posture and mode of breathing, how they should sleep with their windows open at night in order to breathe pure air. It seemed to me an opportune time to have a practical demonstration on air and ventilation that the truths of the lecture might be more clearly understood. The unit on water was brought about by a lead obtained from members of the class. In watering the plants one day, several pupils noticed that the water trickled through the soil and came out clear in the saucers beneath. They immediately questioned why this was. Hence was brought about the purification of water. Again the environment offered the chance of studying the process of artificial ice manufacture.

The unit on food was born of necessity in making clear the talks on health and cleanliness.

In the work on fire and its prevention the time was set aside for it by the Fire Commissioner. However, the methods of making a fire were offered by boy scouts.

The unit on magnets was suggested by watching the children at leisure, noting their keen delight in magnetic attraction and their seemingly endless interest in friction.

Criteria for Selection of Units

Have a special Criteria for selecting the units of Work.

I. Let these units be selected from real life situations. Because the child finds in the selection of the units the opportunity to satisfy his needs.

The real life situation may be one which the child or group selects because of past experiences, or because of being guided by the teacher or because the stage was set and it seemed worth while to the pupils. No unit should be selected if the material for its successful working out is not handy or cannot be readily produced. The unit must at all times be kept near to the present needs.

II. The unit of work should afford many opportunities for real purposing and be something which the child can carry into his normal activity. (1)

III. The unit should stimulate many kinds of activities and so provide for individual differences.

Every child in the group need not engage in every kind of activity, but he must feel that his activity is contributing to the unit as a whole.

IVa The unit of work must make individual growth possible.

Within the range of the activities which take place in the development of the unit of work, each pupil on his intellectual level and on the level of his physical coordination must find it imperative to exert real effort. This means that real growth from one standard of work to the next must take place within the particular unit.

IVb The succession of units of work must provide for continuous group growth from one level to the next.

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(1) Lincoln School Staff. Curriculum Making. p.31.

The main trend of the unit should be well within the grasp of the whole group. (1)

The units must make it possible for the whole group to grow continuously.

Ideally no unit of work should represent the end of individual or class curiosity. An important phase of the teacher's technique is to leave each unit with a feeling that thereis a fascinating field for further investigation. This creates an attitude for continuous individual and group growth.

V. Each unit of work should furnish leads into other related units of work and must stimulate in the child a desire for a continued widening of his interests and understandings.

VI. Each unit ought to help meet the demands of society and help clarify social meanings. It is not enough that the unit relate closely to the present needs of the child or to real life situations. It must make the child more alert to his social environment and help him to understand the meanings of adult society in which he is to have a part. (2)

VII. Each unit should be accompanied by progress in the use of such tool subjects as contribute to that unit.

There should be progressively increasing skill in the use of a tool subject such as reading to allow for the proper enrichment of the unit of work. Through the unit of work a readiness to read develops. The child sees so much which he could do if he could only read well. He is well disposed toward the acquiring of the skill.

VIII. Each unit of work must lead to the development of desirable habits.

The child must find in the unit, possibilities for growth in per-

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(1) Lincoln School Staff. Curriculum Making. p.33, 34.
(2) Lincoln School Staff. Curriculum Making. p.38, 38.

sonal and group responsibility initiative, cooperation, good judgment in proportion to experience, economical methods of study and work, power to plan ahead, open mindedness, fair play, creativeness, courage in self expression, self-direction, sympathy and kindness. (1)

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(1)Lincoln School Staff. Curriculum Making. p.39, 41.

Octopus leadings in Science.

A great deal may be done to bring general science home to the child if we tie it up practically with the other subjects of the curriculum. Much that is valuable may be carried on entirely out of school time, when the school time is limited. Children read considerably, out of school -- if a good suggestion be offered, children will grasp at it and eagerly respond. In the matter of oral English, why not let the child tell of the work of some great scientist that has contributed something of value to the world. In this case his subject is interesting, he has a message to tell his classmates and he is using in a practical manner his science knowledge. We tell of great men in history, surely science is the history of progress.

In arithmetic, instead of dealing with abstract problems that have no bearing on the lives of the children why not have problems that deal with life situations - the cost of material to demonstrate a problem; car fare spent in trips; the reading and figuring of gas meters and gas bills - electric light and water; bringing home to the child concretely that science plays a large part in his life both at school and at home.

Boys and girls of the sixth and seventh grades are interested in Boy Scout and Camp Fire life -- let them have a unit of work that bears directly on that phase of life.

- Fire - how it is made. This may be followed up by Fire Prevention. The subject has been considered important enough to set aside a certain time each year for its observation.

In health education the subject of posture and proper breathing is considered - here might be well applied the subject of ventilation, with

experiments in practical application and not just book reading and discussion.

The girls are preparing for cooking - many perhaps are little noon day mothers who prepare the luhches for themselves and smaller brothers and sisters. No better time could be considered than this for the unit on Food and its Protection.

Magnets and magnetism is always attractive and there is hardly a boy who hasn't lodged deep in his pockets, among fish hooks, knives and old string, a horse shoe magnet of which he never wearies. From time immemorial it has been one of his chief bits of trading stock. Again how tirelessly have children rubbed their pencils back and forth and in mystery and wonder made it pick up minute paper particles. Here indeed a valuable lesson in frictional electricity would turn that seemingly idle amusement into knowledge of real value.

In addition to the various texts used for material for the units of work, I have culled from lectures and demonstrations in the field of general science, given by Mr. Joseph R. Lunt and Mr. Dennis C. Haley at the Boston Teachers College, during the summer of 1927 and the winter of 1928, such parts of the demonstrations as I considered applicable to sixth grade appreciation. These I have combined and assembled to fit my own needs in working out my science program.

UNIT I.

A. Breathing and Ventilation

1. Parts of the body used in Breathing.
2. How air is inhaled and exhaled.
3. Inhaled and exhaled air compared.
4. A study of Ventilation.

B. Carbon Dioxide

1. How to make Carbon Dioxide.
    1. Breathing
    2. Burning
    3. Action of HCL on marble chips
2. Test for Carbon Dioxide.
3. How it affects Fire.
4. Baking Powders.

A. Breathing and Ventilation

I. Parts of the body used in breathing.

Chart: showing the parts of the body used in breathing.

Locate the nose, mouth, pharynx, windpipe or trachea, and the lungs. Trace the path of the air from the nose or mouth down into the lungs. Notice that the windpipe or trachea divides at the upper part of the chest. These two branches are called the bronchi. One branch goes to each lung.

The bronchi divide and subdivide until the branches are very small and finally end in tiny air sacs. These air passages are lined with mucous membranes containing a great many blood vessels. An exceedingly thin membrane separates the air sacs from the blood vessels. Oxygen in the air sacs passes through the membrane into the blood vessels.

Compare the length of the air passage from the mouth to the lungs, with the length of the passage from the nose to the lungs. Notice that the nose passage is considerably longer. This is one reason why we should breathe through the nose and not through the mouth. The long passage containing many blood vessels warms the air before it reaches the lungs. Another reason for nose breathing is, that inside the nose there are many fine hairs which act as a sieve in sifting out dust particles. The sticky surface of the membrane likewise catches many dust particles and germs.

II. How Air is inhaled and exhaled.

Materials: Quart bell jar with open top; one hole stopper; glass tubing 6" long, toy balloon, twine, a square

of sheet rubber with string attached to center. Push the piece of glass tubing through the stopper so that it projects through the stopper about 3". Tie a toy balloon on to the lower end of the glass tubing. Fit stopper into top of the bell jar. Cover the bottom opening of the bell jar with the square of sheet rubber. Fasten the rubber on to the base of the jar with a piece of twine.

This apparatus represents the mechanism of breathing. Let the glass tubing represent the air passage - the toy balloon the lungs and the sheet rubber the diaphragm. Take hold of the string attached to the sheet rubber and pull it down a little. This represents the action of the diaphragm. The diaphragm forms a movable floor to the chest cavity. Notice that air rushes into the toy balloon inside the bell jar. Release the string. Notice that the rubber sheet moves back in place and the toy balloon returns to its former size. Air rushes out of the balloon. This represents the diaphragm when it relaxes. The experiment illustrates the action of the diaphragm in breathing. Air enters the lungs because the muscles of the chest pull the ribs so that they move upward and outward and the muscles of the dome-shaped diaphragm, cause it to move downward. These two actions enlarge the chest cavity, cause a partial vacuum, and the air pressure forces air into the lungs to relieve the partial vacuum.

In the proper kind of breathing, both of these movements go

on together. When the ribs move downward and the diaphragm moves upward, air is expelled from the lungs. In breathing, the lungs should be filled with air. This can be accomplished by keeping the chest and the lower part of the trunk, the abdomen, free from tight clothing; by sitting or standing in a proper position and by breathing deeply at frequent intervals.

III. How inhaled and exhaled air compare.

Materials: 3 large wide mouth bottles, pneumatic trough, rubber tubing 2 feet long, 3 metal squares, 2 candles on wire and a bottle of lime water.

a. Pour half an inch of lime water into a wide mouth bottle. Cover with the palm of the hand and shake it. Notice that there is no appreciable change in the appearance of the lime water. Now lower a burning candle into the bottle containing the lime water. In a few minutes remove the candle. Cover the bottle with the palm of the hand and shake it. Notice that the lime water turns milky. This shows the presence of carbon dioxide. This gas is produced by the burning candle.

b. Fill a wide mouth bottle with water and invert it in the trough of water. Place one end of the rubber tubing under the mouth of the inverted bottle and put the other end in the mouth. Blow through the rubber tubing until all the water in the bottle is displaced. Slide a metal plate under the mouth of the bottle, remove it from the trough and stand upright,

covered, on the table. Pour half an inch of lime water into the bottle of exhaled air. Cover the bottle and shake it. Notice that the lime water turns milky. This shows the presence of Carbon dioxide. In this case the carbon dioxide present in the bottle was produced by breathing.

c. Collect another bottle of exhaled air from the lungs as described in "b". Stand it upright, covered on the desk. Place beside it a bottle of air, covered. Light the candles attached to the wires. Remove the metal covers from the bottles and quickly lower into each a burning candle. Notice that the candle burns longer and brighter in the bottle of fresh air than it does in the bottle of exhaled air. This experiment shows that exhaled air contains less oxygen than fresh air does. Also that exhaled air caused the candle to go out while it burned brightly in the fresh air.

IV. A Study of Ventilation

Materials: Ventilation box, candles.

The ventilation box may be used to show how the air in a room can be kept pure. Let the box represent a room, the candles persons, and the holes on the side near the top and bottom, windows.

a. Close all the openings or windows by pushing corks into the openings. Light the candles and close the door of the box. Watch the candles through the glass front. Notice that the candles soon go out. Oxygen is used up by the candles in burning and carbon dioxide is produced. This represents a room with no ventilation.

b. Open the door of the box and turn the box over to allow the bad air to escape. Open the windows at the bottom of the box by removing the cork stoppers. Relight the candles and close the door. Watch the candles. Notice that the candles dim and soon go out. This represents a room with the windows only open at the bottom. This is not a satisfactory way to ventilate a room. It does not offer any means for the warm impure air to escape and as a result no cool pure air can enter the box through the openings at the bottom.

c. Make sure the box is again free from impure air, and repeat, this time closing the openings at the bottom of the box and removing the corks from the openings at the top. Notice. The candles burn poorly and soon go out again. This represents a room with the windows open only at the top. This is not a satisfactory way to ventilate a room. It does not offer any means for the heavy cool air to enter the box to force the warm impure air out.

d. Repeat the experiment, this time opening the holes or windows at the top and also at the bottom. Notice that the candles continue to burn. This represents a room properly ventilated. The cooler heavier air comes in at the openings at the bottom of the box, and forces out the warmer, lighter, impure air through the openings at the top.

This experiment shows the children clearly that they, like the candles do better work in a well ventilated room.

B. Carbon Dioxide

I. How to make Carbon Dioxide

1. Breathing

2. Burning

3. Action of HCL on marble.

We noted under "A" that Carbon dioxide could be obtained by breathing and also by burning. A greater quantity of it may also be produced by the action of hydrochloric acid on marble.

Materials: Marble chips, hydrochloric acid, thistle tube, glass bend, rubber tubing, metal plate, metal trough, two hole stoppers and three wide mouth bottles.

Place a handful of marble chips in an 8 ounce bottle. Fit the stopper with a thistle tube and a right angle bend. Attach a piece of rubber tubing to the bend. Fit the stopper into the bottle. Place the end of the rubber tubing under the surface of the water in the trough. Fill three bottles with water and invert them in the trough. Put the mouth of one bottle over the end of the delivery tube. Add dilute HCL slowly through the thistle tube. Let the first bubbles of gas escape - They are bubbles of air. Collect three bottles of gas. Slip a metal plate under the mouth of each bottle. Remove them from the trough and stand them upright on the table. Notice that the gas is colorless.

II. How Carbon dioxide affects Fire

Remove the cover from one of the bottles of collected gas. Thrust a blazing splinter into the bottle. The flame immediately goes out. Relight the splint and repeat - until the bottle of gas is

exhausted. Light three candles. Take the second bottle of gas and actually pour it over the lighted candles. They immediately go out as the carbon dioxide rolls over them. This shows concretely that the gas does not support combustion.

III. How to Test for Carbon Dioxide

Take a third bottle of collected gas. Remove the metal plate. Add about half an inch of clear lime water. Notice that the lime water turns milky. This is a positive test f or carbon dioxide. The milky precipitate is calcium corbonate. It is formed by the action of carbon dioxide on lime water.

Now add more HCL.,through the thistle tube. Put the end of the delivery tube into the milky solution. Bubble carbon dioxide gas through the solution until it clears. When an excess of carbon dioxide is passed into the solution, a weak acid, called carbonic acid is formed. The milky precipitate of calcium carbonate is soluble in this acid. Hence the solution becomes clear. This experiment explains the formation of the great limestone cave; such as the Mammoth Cave of Kentucky. Water containing an excess of carbon dioxide passes over beds of calcium carbonate or limestone . The limestone dissolves in the acid formed and is gradually worn away. The gradual wearing away over a period of years results in these large caves.

IV. Baking Powder

Materials: Baking soda, dilute hydrochloric acid, lime water, splints, metal trough, wide mouth bottle and a teaspoon.

Fill the metal trough quarter full of water. Pour a tablespoon-

ful of hydrochloric acid into a wide mouth bottle. Fill the bottle with water. Cover with a metal plate. Invert the bottle and set it mouth downward into the trough of water. Take a teaspoon. Bend it at right angles. Fill this teaspoon with baking soda and hold it under the mouth of the inverted bottle. Notice that gas is produced and soon displaces the water in the bottle. Slip a metal plate under the mouth of the bottle. Remove the bottle and stand it upright. Remove the cover. Add half an inch of clear lime water to the bottle of gas. Shake. Notice that the lime water turns milky. This proves that the gas is carbon dioxide.

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UNIT II

A. Water

1. How water dissolves substances.
2. Are all substances soluble in water.
3. How crystals are formed.
4. Purification of water by Filtration.

* The Metropolitan Water Supply.

B. Ice and Ice Water

1. Three forms of water
2. Does ice absorb heat in melting.
3. Why ise is used for cooling.
4. Ice and salt mixture.

* How artificial ice is made.

C. Steam and Boiling Water

1. How water boils.
2. Temperature of boiling water.
3. Why steam is used for power.

* How the steam engine works.

.....

* Sub topics that may be worked out in greater detail by individuals.

A. Water

I. How water dissolves substances.

Materials: Bottles of sugar, alcohol, glycerine potassium permanganate; test tubes, spoon.

a. Liquids in liquids. Pour about 10 c.c.of water into two small test tubes. Add 10 c.c. of alcohol to one and 10 c.c. of glycerine to the other. Cover each and shake. Notice that both the alcohol and the glycerine disappear or completely dissolve in the water. Some liquids dissolve in one another in all proportions. Alcohol and water and glycerine and water are examples of these substances.

b. Solids in liquids. Fill a large test tube 2/3 full of water. Add to the water in the tube half a teaspoon of sugar, a little at a time. Shake the mixture after each addition. Notice that the sugar completely disappears or dissolves in the water without causing any change in the color of the solution. Fill a test tube with water. Drop 2 or 3 crystals of potassium permanganate into the water. Notice that the crystals drop to the bottom. The color, however, soon begins to be distributed throughout the whole solution. Let it stand over night or even for a few days. Notice that the color diffuses upward through the solution. Some substances give color to the solution they form while others do not.

II. Are all substances soluble in Water

Materials: Bottles of sand, iodine crystals, alcohol, test tubes and a teaspoon.

Fill 2 test tubes half full of water. Into one put half a

teaspoon of sand. Cover the mouth of the tube with the hand and shake it vigorously. Notice that the sand does not dissolve. Let it stand for a few minutes and the sand settles to the bottom.

Into the second test tube of water drop 2 or 3 crystals of iodine. Cover the tube and shake. Notice that the iodine does not dissolve.

Pour about an inch of alcohol into a large test tube. Add 2 or 3 crystals of iodine and shake the tube. The iodine dissolves in the alcohol and gives a deep color to the solution.

This experiment shows that water does not dissolve all substances. It also shows that certain liquids will dissolve substances that are insoluble in water.

III. How Crystals are formed

Materials: Bottle of powdered copper sulphate, powdered alum, crystallizing dishes, test tubes, Bunsen Burner and a hand lens.

Fill 2 large test tubes half full of water. Into one put 2 teaspoonfuls of powdered copper sulphate and in another an equal amount of powdered alum. Dissolve the salt in each test tube by heating the water to boiling. Let the solutions cook for about a minute and pour the copper sulphate solution into one crystallizing dish and the alum solution into the other. Notice that crystals begin to form immediately. Watch the crystals grow. When the crystals are well formed, remove several from the dish. Examine each crystal separately

with a hand lens. Notice that the shape of each crystal of copper sulphate is the same as its neighbor, and also that each crystal of alum is similar to its neighbor. Crystals have sharp edges and a definite crystalline form. They are classified according to their geometrical form. The crystalline forms of substances often enable us to identify the substance.

IV. How Water is Purified by Filtration

Materials: Bottles of sand and salt, spoon, test tubes, filter paper, funnel tube, evaporating dish, wire gauze, ring stand, iron ring, rubber tubing and Bunsen Burner.

Fill a test tube quarter full of water, Add half a teaspoonful of sand and an equal amount of salt to the water. Shake the mixture vigorously. The salt dissolves and the sand does not. Filter the mixture. Fit the filter paper into the funnel and set funnel into a test tube. Having shaken the mixture of sand, water and salt pour it onto the filter paper in the funnel. Let it satnd for a few minutes. Notice that clear water passes through the filter paper.

Insoluble substances like sand or dirt may be separated from water by filtration. Now pour the clear water that passed through the filter paper into the evaporating dish. Set the dish on the wire gauze on the ring stand and evaporate the water to dryness. Notice the white deposit left in the evaporating dish after the water is evaporated. Taste it. The deposit is salt. The experiment shows that insoluble

materials may be separated from water by filtration, but materials dissolved in water cannot. Filters are not always made of paper. A thick layer of sand and gravel or a layer of charcoal acts as a filter. Some cities use sand filters to purify their water supplies.

V. A Study of the Metropolitan Water Supply

This may be studied as a bit of independent work by individuals interested in further study.

Locating the three large water sheds, the Wachusett, the Sudbury and the Cochituate. Locating the aqueducts that connect the reservoirs - the Wachusett, Sudbury, Cochituate and the Chestnut Hill reservoir.

Locating the various filter beds throughout the district. Noting the districts that have their own water supply.

B. Ice and Ice Water

I. Three Forms of Water

Materials: Kettle, ring stand, iron ring, Bunsen burner, and a piece of ice.

Take a piece of ice about the size of an egg. This is water in the solid form. Hold it in the palm of the hand for a few seconds. The ice begins to melt or change to water. Put the ice in the kettle and place the kettle over the lighted Bunsen burner. The ice melts fast and soon changes to water. Heat the water until it boils. Continue heating until all the water disappears or changes to steam. This experiment shows that water exists in three forms; as a solid, a liquid and a gas.

II. Does ice absorb heat when it melts?

Heat about a quart of water in the kettle until it boils. Fill a beaker about one fourth full of finely chipped ice. Take the temperature of the chipped ice. It is 32° F. Now take the temperature of the boiling water. It is 212° F.

Pour the boiling water onto the ice in the beaker. Fill the beaker with boiling water. Notice that the ice melts and completely disappears. Now take the temperature of the water in the beaker. It is somewhere between 32° F and 212° F. The hot water melted the ice and the ice in melting absorbed a great amount of heat from the boiling water. This experiment shows that ice requires heat to melt it.

III. Why Ice is used for Cooling

Fill a beaker half full of finely chipped ice. Take the temperature of the ice. It is 32° F. Now add two glasses of water to the

beaker. Stir the ice and the water with the thermometer. Stir until the thermometer reads 32° F. Now take two bottles, into each pour a glass, even full, of warm water. Take the temperature of the warm water in each bottle. It should be the same. Into the first add ice water at 32° F. Into the second bottle drop bits of ice until the water level of the second bottle is even with that of the first. Cover the mouth of the bottle with the palm of the hand and shake the mixture until all the ice is melted. Take the temperature of the water in each bottle. Ice lowered the temperature of the water in the second bottle or cooled it much more than the ice water did which was added to the water in the first bottle. This experiment shows why ice feels cold; why it is used in refrigerators, and why it is used for cooling purposes. When ice melts it uses up a great deal of heat. In melting it takes this heat from the things that surround it. This means that the surroundings are cooled.

IV. Is a mixture of salt and ice colder than ice.

Fill the beaker about one fourth full of finely chipped ice. Push the bulb of the thermometer down into the ice and read the temperature. Remove the thermometer.

Now add about a drinking glass full of coarse salt to the ice. Work the salt down into the ice. At the end of a few minutes take the temperature of the mixture. The temperature is considerably lower than 32° F. The experiment shows that the temperature of a mixture of salt and ice is much lower than the temperature of ice alone. Since a low temperature is made possible by mixing salt and ice these substances are used to make freezing mixtures in

making ice cream and artificial ice.

V. How Artificial Ice is made.

This topic was selected as a bit of independent study by pupils interested in the further pursuit of the work. An ice plant being operated in the environment gave a splendid opportunity to observe the process.

C. Steam and Boiling Water

I. How water boils.

Materials: Ring stand, iron ring, wire gauze, Erlenmeyer flask, Bunsen burner.

Half fill the flask with water from the tap. Set the flask on the stand and place a lighted Bunsen burner under it. Watch the flask until it boils. Notice that bubbles soon form at the bottom and on the sides of the flask. They rise through the water and escape at the surface. These are air bubbles. Watch the bottom of the flask. Notice that larger bubbles form, rise a short distance and then disappear. These are steam bubbles that condense or collapse when they reach the upper, cooler layers of water. This is what causes the hissing or singing of the kettle. As the water becomes hotter, these large steam bubbles rise higher before disappearing. Finally, when they reach the surface of the water and escape, the water is said to boil.

II. The Temperature of Boiling Water

Heat half a flask of water until it boils, vigorously. Take the temperature of the boiling water. Notice that the temperature of boiling water is about 212° F. At normal pressure, water boils at 212° F. Now turn down the gas so that the water boils slowly. Note that the temperature of the water is the same as when it boils vigorously. To save gas in cooking vegetables, partly close the gas cock as soon as the water starts to boil. The extra heat used, doesn't cook the food any quicker, but simply evaporates the water.

III. Why Steam is used for Power

Put five or six drops of water in a test tube. Push a cork stopper lightly into the mouth of the tube. Hold the test tube in the Bunsen flame for a few seconds. Keep the tube at arm's length and pointing away from any one. The stopper is soon blown out of the test tube. The heat of the flame changed the water to steam. Steam takes up about 1600 times as much space as the water from which it comes. The space inside the tube was not large enough for the great volume of steam produced and so the stopper was blown out. The pressure caused by expanding steam in the cylinder of a locomotive, pushes the piston back and forth thus making possible great power.

IV. How the steam engine works

This topic was selected to allow for further study of the subject, and independent work on the part of the individual who desired to do more.

References - for Unit II.

Caldwell and Meir	Open Doors to Science. p. 20, 21,146.
Hessler, J.C.	Junior Science. p. 143, 160.
Hodgdon, D.R.	Junior General Science p. 94, 95, 100.
Lunt and Haley	Lectures and Demonstrations. 1927, 1928.
Tower and Lunt	The Science of Common Things. p.66-70, 73-77, 92.
Webb and Didcoct	Early Steps in Science. p. 160-161.

UNIT III

A. Fuel and Fire

1. A study of common fuels

solid - liquid - gas.

2. How to kindle fire with a bow and drill.

3. How to kindle with flint and steel.

4. Kindling Temperatures.

B. Fire Prevention

1. How a fire starts itself.

2. How water puts out a fire.

3. How to put out burning grease.

4. How to prevent fires.

A. Fuel and Fire

I. A Study of Common Fuels

Classified in three groups.

Solid - Liquid - Gas.

Solid:

Wood, soft coal, hard coal, charcoal, coke, peat - are the solid fuels.

Liquid:

Kerosene, gasoline, alcohol and fuel oil - are the liquid fuels.

Gas:

Illuminating gas is an example of a gaseous fuel.

II. How to start a fire with bow and drill.

Materials: Bow, drill, cedar board and tinder.

Assemble the bow.

Place the board with notches in it on the floor. Take a small amount of finely shredded cedar bark, flatten it out and place it under one of the notches. Put the pointed end of the drill into one of the notches in the cedar board. Hold the drill in place, erect with the left hand. Keep the board firmly on the floor with the left foot. Kneel on one knee. Grasp the end of the bow with the right hand. Move the bow in a horizontal direction back and forth, so that the drill revolves. Slowly at first and then rapidly. The board will begin to smoke. Continue. Friction has heated the board so hot that little sparks of glowing carbon fall down into the cedar bark in the notch. Blow on the bark where the spark has fallen. When the

bark begins to smoke, fold it close together to keep the heat from escaping. Continue to blow until the tinder bursts into flame.

In this experiment friction caused sufficient heat to start small bits of carbon glowing. The tinder of cedar bark is finely shredded and well surrounded with air. The small threads of bark are easily raised to the kindling temperature.

III. To kindle a fire with flint and steel.

Take a 4-inch square of cotton cloth. Set it afire. Let the cloth burn until it is black. Drop it on a tin plate, put out any flame in the charred cloth. Place the charred cloth or tinder on a piece of tissue paper. Take a stone in the left hand, strike it a quick glancing blow with the flat edge of a file. Direct the spark to the tinder and blow gently. When it begins to smoke, pick up the paper, fold it around the tinder and blow until the paper bursts into flame.

The sparks are small pieces of glowing steel heated red hot by friction.

IV. Kindling Temperatures.

Materials: Bunsen burner, candle, tongs, 3 tin covers, tissue paper, sulphur, coal.

Place a good pinch of sulphur on a tin cover. Pick the cover up with the tongs. Hold the cover in the candle flame until the sulphur takes fire.

Crumble a piece of tissue paper into a wad about the size of a marble. Place the wad on a clean tin cover. Hold in the candle flame. Notice that the paper does not take fire. Hold the

bottom of the tin in the Bunsen flame - The paper burns.

Place about half a teaspoonful of soft coal in the third cover. Hold it in the flame. The coal does not kindle. It has a higher kindling temperature than either sulphur or paper.

All substances do not kindle at the same temperature. The heat of the candle was sufficient to kindle sulphur, the heat of the Bunsen burner to kindle paper, but coal has a kindling temperature higher than either of these.

B. Fire Prevention

I. How a fire starts itself

Disastrous fires frequently start themselves in piles of rubbish, damp hay, damp straw, oil waste, and rags saturated with grease paint or turpentine. Perhaps you have seen piles of manure steam and burn when they are turned over in the spring. The following experiment will show you how fires can start themselves.

Put two teaspoonfuls of carbon disulphide into a small beaker. Keep this away from a flame. Drop a tiny piece of phosphorus into the beaker. Let the phosphorous dissolve in the carbon disulphide. Lay a sheet of paper on an iron ring on a ring stand. Carefully pour some of the liquid from the beaker over the paper. Watch the paper. It burst into flames.

Rags saturated with grease, paint, oil or turpentine sometimes act in a similar manner though much more slowly. Do not let piles of rubbish accumulate in your homes. Burn greasy rags or put them in metal containers.

II. How water puts out a fire.

Set a shallow pan on a support and build a fire in it using not more than a dozen small splints of wood. Fill a squirt gun with water. When the fire is burning briskly squirt a little water over the fuel. The fire is extinguished almost immediately.

Water puts out fire for several reasons. The film of water excludes oxygen. The water evaporates and evaporation is a cooling process. Heat is taken from the burning fuel until it is cooled below the kindling point.

III. How to put out burning grease.

Many disastrous fires are caused by burning grease and fat.

Sometimes the containers are upset on the stove. More frequently the fat is heated so hot that it takes fire. The throwing of water on burning fat may lead to serious results. Water is heavier than fat. It sinks and changes to steam. The steam expands and causes an explosion throwing the burning fat all over the room.

Support a small crucible on the ring stand. Fill it about half full of paraffin. Heat the paraffin until it melts and becomes quite hot. Pick up a little water with a piece of glass tubing. Stand away from the crucible and drop the water into the hot paraffin. Note the result. The flame shoots up very high. Put a cover over the crucible - The fire goes out at once. The cover shuts off the air, needed for combustion. Fires of grease or fat may be put out with sand or dirt, never use water.

IV. How to Prevent Fires.

The loss by fire of human lives and property in the United States every year is appalling. It is a terrible story of suffering, death, and destruction. What precautions have you taken to guard your home from the "Demon Fire."

Be a good home fire warden.

Use safety matches in your homes.

Place these matches in metal containers and out of the reach of small children.

Clean your cellars, backstairs and yards.

Put oil, paint, or grease rags in a metal container or burn them. Do not allow them to accumulate.

Be careful in the use of naptha, gasoline and benzine for cleansing purposes.

Is the gas jet in your room near the window? If so be careful of a draught blowing the curtains near the flame.

Does your home need a fire escape?

Do you know the nearest fire alarm box?

Warn members of your family about smoking in bed. Also the careless discarding of glowing cigarette or cigar ends.

References - for Unit III.

Caldwell and Meier — Open doors to Science. p.103-113, 153, 154, 175, 161.

Hessler, J.C. — Junior Science. p. 27.

Hill,H.C. — Community Life and Civic Problems. p. 219, 239, 240.

Hodgdon, D.R. — Junior General Science. p. 91.

Lunt and Haley — Lectures and Demonstrations. 1927, 1928.

Tower and Lunt. — The Science of Common Things. p. 165, 169, 170.

Webb and Didcoct — Early Steps in Science. p. 40, 45, 59, 184-186.

UNIT IV

Food and Its Protection

1. How Bacteria spoils food.
2. How to grow Bacteria.
3. How to kill Bacteria.
* 4. The House Fly.

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* Sub-topic for enlargement and independent investigation.

Food and Its Protection

I. How bacteria spoils food

Materials: Four test tubes, cotton batten, labels, small kettle, ring stand, ring, Bunsen burner, milk and ice.

Set four clean test tubes in a rack. Fill each half full of fresh milk. Put about three inches of water in the kettle. Set one of the tubes of milk in the water. Boil for about ten minutes. Put a wad of cotton in the mouths of all the tubes except number 3.

Label the tubes as follows:

No.1 - On ice-closed. No.3 - Warm-open

No.2 - Warm-closed. No.4 - Boiled - closed.

Put tube No. 1 on ice. Set the other tubes in a warm place for about two days, then examine them. Note the result.

No. 1 on ice, closed, not sour. Cold checks the growth of bacteria.

No. 2 warm- closed, slightly sour. Warmth helps bacteria to multiply.

No. 3 warm, open, very sour. Bacteria fell into the tube from the air.

No. 4 boiled, closed - not sour. Heat kills bacteria.

Bacteria cause the decay and spoiling of most perishable foods such as milk, meats and fish. For this reason we keep our foods covered, have our milk pasteurized and use refrigeration as a protection against bacteria.

II. How to grow Bacteria

In order to grow, bacteria must have food, like other plants. The most satisfactory food to use is Bacto Nutrient agar. For immediate use it is more convenient to pour melted agar into test tubes. Pour about two inches into each test tube carefully. Plug each tube with a loose wad of cotton. Set the tubes of agar in the kettle of water and boil them for at least 30 minutes. Remove the tubes from the water

and use them in the following manner. Pour a tube of Bacto Nutrient agar into two sterilized Petri dishes. Let the agar harden. Plant the two gardens as follows: Raise the glass cover of one dish and touch the surface of the agar with dusty finger tips. Replace the cover. Label the dish No. 1. "Dirty Hands"

Let the hands then be washed thoroughly and dried in a clean towel. Raise the cover of the second Petri dish and touch the agar with clean finger tips. Replace the cover. Label the dish No. 2. "Clean Hands". Set the two dishes away in a warm dark place. Examine the dishes, at the end of three or four days. Notice the colonies of bacteria. Dish No. 1 contains more colonies than Dish No. 2. Dish No. 1 was touched with dusty fingers. Washing the hands is a good precaution before eating or handling food.

Why coughing is dangerous.

Pour agar into another Petri dish and let it harden. Remove the glass cover. Hold the dish about one foot away and cough or sneeze several times at it. Set the dish away, having replaced the cover, in a warm dark place. Examine at the end of three days. Notice the colonies of bacteria. These colonies came from coughing and sneezing. Cover your mouth when you cough or sneeze so that you will not spread bacteria.

III. <u>How to kill Bacteria</u>.

With a needle, transfer some of the bacteria from colonies previously raised to a Petri dish containing agar. Set the dish on a window sill in a warm room in the direct sunlight. Examine it at the end of three or four days. Notice that there are no bacteria where the sunlight shone directly on the agar. Direct sunlight kills many bacteria. This experiment shows that sunny rooms are more health-

ful than dark rooms. Do not draw the shades to shut out the sunlight in your homes. Hospitals realize the value of sunlight in killing bacteria,and have many sun rooms for their patients. Heat too kills bacteria. For this reason surgeons boil their instruments before using them. Sometimes we boil our drinking water to kill the bacteria. In canning fruits and vegetables at home we sterelize the containers to destroy the bacteria.

IV. How diseases are carried by the house fly.

Pour agar into a sterilized Petri dish and let it harden. Catch a house fly. Raise one edge of the glass cover and drop the fly into the dish. Let him walk across the surface of the agar several times, then release him. Set the Petri dish away in a warm dark place. Examine it at the end of three or four days. Notice the colonies of bacteria. These colonies came from the fly. Flies carry disease germs. Protect your food from flies. Guard against flies in your homes.

References for - Unit IV.

Caldwell and Meier	Open Doors to Science. p. 241, 252, 257, 271.
Hessler, John C.	Junior Science. p. 229.
Hodgdon, D.R.	Junior General Science. p.175.
Lunt and Haley	Lectures and Demonstrations. 1927, 1928
Tower and Lunt	The Science of Common Things. p.351-352, 356, 358, 362.
Webb and Didcoct	Early Steps in Science. p. 166, 167, 191, 530, 531.

UNIT V

A. Magnets

1. Study of a natural magnet.
2. Do magnets attract all materials
3. The Poles of a magnet
4. To discover the law of magnets
5. What is magnetism.

B. Frictional electricity

As a basis for the better understanding of electricity.

A. Magnets

I. Study of a natural magnet

Materials: Lodestone, iron filings, carpet tacks.

Examine the lodestone. Notice its weight. Try to pick up a tack. Notice that the lodestone is a magnet, a natural magnet. Its properties were known even among the ancient Greeks and Romans.

II. Do magnets attract all materials?

Materials: Bar magnet, horeshoe magnet, and a package containing pieces of iron, steel, nickel, brass, copper, lead, zinc, aluminum, paper, wood and rubber.

Try to pick up various articles with the magnets. Result. The magnets attract only articles made of iron, nickel and steel.

III. The Poles of a magnet.

Materials: Bar magnet, iron filings, a sheet of paper.

Pour a handful of iron filings on a sheet of paper. Roll the bar magnet evenly and completely in the iron filings. Lift the bar magnet by the middle. Notice that the iron filings cling in tufts to each end of the magnet. Almost no iron filings cling to the central part. The magnetic strength seems to locate at either end of the magnet. The ends are called poles. One pole, marked N is a north pole. The other pole, marked S, is the south pole.

IV. To Discover the law of Magnets.

Materials: Black's magnet holder, and 2 bar magnets.

Balance one bar magnet on the holder so that the magnet will rotate freely in a horizontal position. Hold the second bar magnet in the hand. Bring two north poles together, Notice that they push each other away or repel each other. Bring two south poles close together. Notice that the south poles repel each other.

Bring a north pole near a south pole. Notice that they attract each other. Like poles repel. Unlike poles attract. This experiment shows us the law of magnets.

V. What is Magnetism

Materials: Test tube, stopper, iron filings, magnetic needle on a stand, horseshoe magnet.

Fill a test tube with iron filings and stopper it. Take a horseshoe magnet. Lay the end of the test tube of iron filings horizontal across the ends of both poles of the horseshoe magnet. Turn the test tube around and around about 12 Turns. Now bring the end of the test tube near the north pole of the compass needle. Bring it near the south pole of the needle. Notice that the tube of iron filings attracts one pole and repels the other. The tube of iron filings is a magnet. Now shake up the iron filings in the tube. Test again for magnetism with the compass needle. This time the iron filings attract both poles. The tube of filings has lost its magnetism. Repeat several times. The horseshoe magnet arranges the filings end to end in rows with similiar poles pointing in the same direction. Shaking, destroys this arrangement and also the magnetism. Repulsion, not attraction is the True test of magnetism.

B. Frictional Electricity

Tear paper into small pieces. Rub a fountain pen briskly on your coat sleeve. Bring it close to the tiny particles of paper. Notice how they cling to the pen.

Stretch a piece of twine taut across the room. Tack the ends in place. Blow up two toy balloons and tie the mouths with twine. Suspend the balloons from the stretched twine. Let them hang parallel about one foot apart.

Rub one balloon briskly with fur, several times. Bring one hand near the balloon. Notice that the balloon flies up and hits the hand. Rub both balloons with the fur. Notice that now the balloons repel each other. Put your head between the balloons. Notice that they both cling to your head. Why do the balloons behave so strangely?

When the balloon was rubbed with the fur some of the electricity was rubbed off the fur onto the balloon , so that the balloon had more than the usual amount of electricity, and the fur had less. We call electricity on the balloon negative and that on the fur, positive.

When any object has more than the usual amount of electricity we call the electricity negative. When an object has less than the usual amount, the electricity is positive.

In rubbing the balloon with fur, you simply rubbed off of the fur countless tiny particles called electrons. All bodies contain two kinds of electricity, positive and negative but it is only the negative electricity, or electrons in a body that can move. The positive electricity stays where it is. A body that has an equal amount of positive and negative electricity appears to have none

at all and is said to be uncharged. Sometimes when two bodies are rubbed together, some of the electrons leave one and go to the other. The one that has gained electrons now has an excess of them and is charged negatively or minus, while the one that has lost electrons, now lacks its usual number and is charged positively or plus. It has not gained any positive electricity but has become positive through the loss of some of its negative electrons. This experiment serves as a basis for the better understanding of practical electrical phenomena.

References - for Unit V.

Hessler, J.C.	Junior Science. p. 235, 238, 245.
Hodgdon, D.R.	Junior General Science. p. 225, 226, 228.
Lunt and Haley	Lectures and Demonstrations. 1927, 1928.
Tower and Lunt	The Science of Common Things. p. 260, 296.
Webb and Didcoct	Early Steps in Science. p.233.

Motivation of Units

Having chosen the units the next important step is the successful carrying out of the work. Let the children help solve this problem.

I. Organize a Science Club

Let this club feature both in and outside the school hours. Have it comprise of pupils vitally interested in the work--membership resting on the interest displayed and the contributions made to the successful carrying out of the work. Children are sociable, they love to share their ideas and plans with others. They will choose things from the child's point of view.

Since all children are not equally equipped sub committees may be formed to allow for individual differences.

Those children who are particularly gifted in hand work may become -

a. Chart makers and thus contribute vitally to the good work of the Club.

Others endowed with constructive ability can use that gift in making useful apparatus for the unit. Here they may enlist their parents, friends and even past graduates to lend a hand.

b. A group of caretakers may be formed whose duty it is to examine all the apparatus needed for a special unit of work, assemble it, select the drawing or chart to be used and have everything in readiness so that when the demonstration is to be made there is no loss of time.

c. The entertainment Committee is always a source of hope and pride.

These pupils may demonstrate the experiments in their home rooms, to parallel grades or even in the hall on special occasions. Here the lantern slides may be used to great advantage, and happy is the lad whose ability enables him to sort and insert the slides properly.

d. Bulletin-Board keepers have their share in the success of the work. This gives an opportunity for originality in slogans and posters: Making announcements of the worthy contributors,- Noting the approach of the early birds,- trips planned,- experiments to be worked out,- meetings of the club,- good suggestions made at the meetings,- issuing invitations to other classes to attend the experiments,- writing to concerns and manufacturers for literature and material.

Since the urge for collecting is strong in every child from whistles to foreign stamps, have established

e. Scrap Book Makers whose duty it is to collect material relating to science - either editorials or exhibits. Give them a corner of the cabinet where they may exhibit their wares in a fitting manner. Here those who excel in penmanship, neatness and printing may label the articles, paste the editorials in books and keep a record of the work done in a Progress Year Book,

By these simple devices every child feels that he has some interest in the unit and that his contribution is of vital importance to the success of the whole. In this way no one group or individual is carrying off all the honors - it is equally divided among the whole class, each one respecting and

appreciating the contribution of the other - that each part is necessary to the great mechanism of the whole.

The Club meets before school - at recess - at home or in leisure time.

The club activities are carried on harmoniously.

Children are more critical of one another than any teacher would be.

If the responsibility for the success of the work is placed on their shoulders self respect and personal group pride enters into the work.

Besides the club activities the work may be greatly enriched by -

II. Trips and Visits

Field trips for the study of soil, birds and trees.

Visiting the Childrens' Museum at Jamaica Plain where they may see exhibits and attend lectures.

Visits to the Air Port.

The Deerfoot Farm for the milk supply.

The Hood Rubber Plant at Watertown.

The Boston Ice Company for the manufacture of Artificial Ice.

The Metropolitan Water Supply, bringing back information to the members of the class and explaning by use of charts and exhibits.

III. Visual Education plays a very large part in the study of Science. The whole work is made more interesting and real if the science field can be made a great moving picture showing the progress of

man -

Moving pictures - lantern slides, charts and drawings, even the crude work done by the children themselves makes the whole thing clearer.

Through visual education they can be made to see that science work never stands still - it is actually living and moving interestingly.

IV. The library plays a most important part in the science work. It keeps individuals abreast of the times. The history of health and disease - how man learned to care for himself. The biographies of pioneers in scientific exploration and discovery make valuable backgrounds for the work.

The habit of science reading should be inculcated early, allowing the child to see what the past has contribuated to scientific progress. An early taste for this kind of reading if well established will function throughout life.

Pupils may often seek experiments which they would like to demonstrate. Here of course great patience is needed, especially at first.

However, let the class evaluate the experiments submitted. They soon learn to select the significant. One must not be over critical in the beginning for harsh criticism dampens the ardor and stifles the enthusiasm. Accept, and then by the process of elimination choose the best.

V. Subscription to Editorials and Magazines on Science.

Encourage the children to read and subscribe to such magazines.

The Science Class Room Pop.Science Pub. Co.

The National Geographic Journal.

VI. The establishment of a School Paper

Writing up Scientific Contributions

The things we have accomplished.

VII. Making use of Presents received at Christmas Time

The Chemistry Outfit.-

Allowing children to bring their sets to school and work out certain experiments in class.

VIII. Extra Curricula Activities

A comparison of the Primitive and the modern home - either by chart work or pictures collected and then assembled as to-

Light

Heat and Ventilation

Sanitation

Labor Saving Devices

Luxuries

Conclusion:

The teaching of general science through units of work in which children are vitally interested, those taken from life situations, and simple enough in their application, not only provide a working foundation of knowledge, but develop interest, observation and habits of industry which in turn build up worthy personal characteristics and creative skill and ability.

The science subject is no longer an isolated factor in their work but an actual part of their lives, a living, moving force which promotes development, satifies a need, broadens their outlook and forms a closer kinship between nature and life.

The atmosphere of the school becomes different with the child as the center and the work revolving about him. The bond between the school and the home is strengthened, for the problems of life at home and abroad are brought to the school for solution.

There are various ways in which the school can tell whether or not the work is successful but the most obvious is the response the children make, the degree of enthusiasm with which they attack the subject. This information may be obtained by -

Checking the Work

Since, however, these science units are worked out as an appreciation there can be no hard and fast checking as children are not held to an account, but only as one desires a general view of the outcome for his personal satisfaction.

The checking may be done in this manner -

I. A graph is kept upon which the names of the children appear. Every time a child makes a report, brings in a contribution either of apparatus or material, he receives a check after his name.

II A record is kept of the number of times experiments are given outside the classroom, to parallel grades, to the assemblies or on special occasions.

III A list is kept of the problems brought in to be worked out by the class and a credit is given to pupils offering the best solutions.- such problems for instance as the following:

a. Readings taken from the gas,electric light and water meters and the figuring of the amount to be paid.

b. Faulty gas flames and how they may be adjusted.

c. Undeveloped or neglected plants, the probable causes of failure to grow and how they may be helped.

Environmental Checks

The study of the units of work makes the observation keener and carries with it a certain civic pride and respect as in,

1. Observing and buying in clean stores, those free from flies and where the food is covered - Bakeries, Markets and candy stores.
2. Noting well ventilated homes, churches,schools and Moving Picture Houses.
3. Disposing of Refuse.
4. 'Cleaning'up cellars and backyards.
5. Protecting home food from flies and bacteria.
6. Respecting salt placed on hydrants.
7. Respecting lamp post and electric lights etc.
8. Care in the use of matches.
9. Noting the fire house in one's district and the nearest fire box.
10. Maintaining a greater regard for civic beauty.

I. Personal habits developed.

II. Creative Outcomes.

In looking back over the field of work is it not natural to ask what one hopes to achieve for the pupil by this work in his habits and attitudes.

The work carried on in this manner aims at giving opportunity and encouraging the right practices of -

a. Responsibility -

In the group - the hall - the assembly. Accepting a fair share of responsibility. Contributing to the success of the work, keeping the quality of the work high.

b. Initiative -

Suggesting new undertakings

Individual enterprises

Using resources at one's command

Willing to act on suggestion

Ability to plan ahead (1)

c. Cooperation -

Ability to work well in a group

Volunteering help

Dependence

Giving and receiving criticism kindly

Accepting leadership

d. Work habits -

Keeping material in working order

Intelligent Planning

Making good use of the library, and reference material

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(1) Lincoln School Staff Curriculum Making. p.290, 291.

Good execution

e. Consideration of others -

Definite standards of behavior

Respecting difference of opinion

Sympathetic understanding of others

f. Honesty and Trustworthiness -

Respectful of the rights of others and also of their property

Giving full value to the suggestions of others

Voting for the best qualified person. (1)

II. Creative Outcomes

There are valuable outcomes that are evident as a result of such work among children as:

Growth in skill in handling material (2)

The habit of planning before executing

The selection of the significant

Ability to report findings to the class

Improved study habits

A scientific attitude toward reference material

A growing interest in the work

An investigative attitude

Correlation with other studies (3)

Reading & English-Use of the library-the reading and reporting

Spelling - investigation of the correct spelling of words used.

Arithmetic - Use of problems from the work

Writing - Writing of reports, invitations - corresponding to concerns and manufacturers

History - Works of the Pioneers in Science.

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(1) Lincoln School Staff Curriculum Making p. 292
(2) & (3) Lincoln School Staff Curriculum Making p. 211

Ability to forge ahead on some individual project suggested by the unit. Using - charts, drawings, pictures.

The Metropolitan Water Supply

The Manufacture of Artificial Ice

The House Fly

Milk and Food Protection

The Mammoth Caves in Kentucky

The steam engine

The Primitive and Modern Home.

All these are touched upon simply in the units and lend themselves to further and interesting treatment by individuals desiring to carry the work on more extensively wherever his interest leads him.

Summary:

In this work an attempt has been made to show how General Science taught as an appreciation, actually functions. Primarily, the aim in an appreciation, is pure enjoyment, yet science taught in this manner, not only gives entertainment but diffuses much practical knowledge. When children enjoy a piece of work, their interest is keen and their attention well sustained and while seeming only to enjoy, they absorb considerable. The units have been kept simple, practical, and interesting. The work was intended to create a love for the subject of science by making it of value to the child. Also to satisfy the spirit of curiosity among boys and girls, to enrich their lives with useful knowledge and its practical application and to plant the seeds for future investigation.

The child has been considered the center of the work, and his environment and needs have influenced the choice of units. By allowing children a considerable share in carrying on the work, confidence in their ability was recognized, which in turn established self confidence, responsibility and resourcefulness. Individual differences were recognized. The fact that society is always injured when any member buries his talents, that social talent is but the sum total of individual talents and hence each member should contribute his share to the success of the whole. To enable children to build up skills, attitudes, characteristics and a view point which will help fit them for the responsibilities of later social life.

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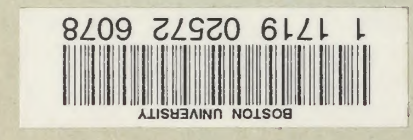
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